DENSITY CHANGES AND HABITAT AFFINITIES OF RODENTS OF SHADSCALE AND SAGEBRUSH ASSOCIATIONS

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Abstract.— Rodent trapping was conducted in representative northern Great Basin habitat types for six consecutive years to determine the magnitude of density change, the specific habitat affinities, and the effects of habitat alteration on rodent density. Although species responded differently, total rodent density was greater in depleted shadscale and sagebrush communities than in comparable pristine sites. However, disturbed sites with nearly pure stands of weedy introduced annuals supported few rodents.

Several species exhibited abrupt and concurrent yearly changes in density. The factors causing these changes were not identified. Until this information is available, we can develop only crude models to predict the direction and magnitude of population change.

Population ecologists lack information regarding the magnitude of density changes in small mammal populations. Ideally, population studies should extend over a sufficient time span to determine not only a mean density but also provide some estimate of the expected deviations from that mean. We are not aware of such a study in the Intermountain West.

Ecologists have gained some understanding of the habitat affinities of the more common rodents. The deer mouse (*Peromyscus maniculatus*) is recognized as eurytopic, while other species are known to be restricted to a few habitat types. The presettlement habitat affinities of most western species may never be fully known because of land clearing, livestock grazing, and the establishment of weedy annuals which are maintained in nearly pure stands by periodic fires.

The senior author began studies of small mammal populations in southern Idaho in 1951 in an effort to (1) determine the species representation in specific habitat types, (2) measure the magnitude of rodent density changes, and (3) determine the effects of habitat alteration on both species composition and density.

The press of other work prevented regular yearly sampling; however, trapping data are available for six consecutive years (1955-60) for several common habitat types of the northern Great Basin. Most of the trapping was conducted near Malta, Cassia County, Idaho, with additional investigations in Owyhee, Elmore, and Weiser counties. Sites were usually trapped during the summer months, although seasonal trapping was conducted in the Raft River Valley in 1957.

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Methods

Transect lines of 50 Museum Special traps were set out at 10-foot intervals and baited with rolled oats. The lines were maintained three days and checked twice daily to rebait and recover the catch. Effort was made to trap in stands of homogeneous vegetation. The habitat types were identified by the dominant plant species present, including big sagebrush (*Artemisia tridentata*), shadscale (*Atriplex confertifolia*), wheatgrass (*Agropyron cristatum* and *Agropyron desertorum*), kochia (*Kochia americana*), greasewood (*Sarcobatus vermiculatus*), and halogeton (*Halogeton glomeratus*).

The number, sex, and age group of each capture was recorded. An index of density (N/100 trap days) was calculated. Trapping at most sites was made in replication and the results reported as means. We made no effort to convert indices of abundance to density estimates. However, density and the catch from index lines are closely correlated (Hansson, 1967; Petticrew and Sadlier, 1970). We believe that these data accurately reflect density changes in these populations.

Results

Deer mice were the most abundant and ubiquitous species trapped in the Raft River Valley, often comprising 60-80 percent of the catch (Table 1). Depletion of shadscale and sagebrush-grass communities favors its increase. Deer mice were about twice as numerous in depleted shadscale stands in the Raft River Valley as in those in better condition (Table 1). No truly pristine shadscale stands remain in the valley after a long history of heavy grazing (Tisdale and Zappetini, 1953) and insect defoliation (Mackie, 1958). As a consequence, deer mice remained the most numerous rodent trapped in depleted stands as well as in those in better condition. In the more pristine shadscale and winterfat (*Eurotia lanata*) communities near Mountain Home, Elmore County, the catch of chisel-toothed kangaroo rats (*Dipodomys microps*) and Great Basin pocket mice (*Perognathus parvus*) regularly exceeded that of deer mice.

Deer mice were 8-9 times more numerous outside a 40-acre exclosure established in big sagebrush near Burley, Cassia County (Table 2). The grass understory outside the exclosure consisted almost entirely of cheatgrass (*Bromus tectorum*), while that inside included perennial species such as *Agropyron trachycaulum*, *Stipa comata*, and *Sitanion hystrix*. The vegetation within the exclosure had been protected from livestock since 1930 (Piemeisel, 1945).

Deer mice were the most abundant rodent trapped in saltsage (*Atriplex nuttalli*), black sage (*Artemisia arbuscula*), and Utah juniper (*Juniperus utahensis*) in the Raft River Valley and in mountain mahogany (*Cercocarpus ledifolius*) and western juniper (*J. occidentalis*) communities in Owyhee County.

Least chipmunks (*Eutamias minimus*) were most common in depleted shadscale stands, where their numbers averaged about 10 times greater than in stands in better condition (Table 3). Although none

TABLE 1. Mean catch of deer mice (N/100 trap days), Raft River Valley. Percent of total catch in parentheses.

Year	Month	Big Sagebrush	Shadscale Healthy	Shadscale Depleted	Crested Wheatgrass	Kochia	Greasewood	Halogeton
1955	Jul			4.3(28)			4.4(37)	
1956	Jul-Aug	12.0(68)	4.7(31)	9.2(63)	11.7(53)		5.0(43)	17.7(74)
1957	Apr	22.0(82)	16.3(67)	17.3(75)	14.2(64)			21.8(75)
	Jun	15.1(54)	4.7(24)	20.3(65)	23.7(76)	10.0(49)		25.7(69)
	Aug	5.0(52)	4.3(32)	14.0(72)	18.1(81)	6.3(50)		12.7(76)
1958	Aug	18.0(79)	11.3(50)	20.0(64)	11.3(68)	9.3(70)		
1959	Jun-Jul.	1.3(36)	0	3.2(27)	2.7(67)	1.7(33)	2.7(32)	
1960	Jun	15.3(92)	13.0(70)	20.7(77)	7.3(79)	3.0(43)		
	Aug			13.0(67)				
1964	May	46.7(85)		18.0(71)	18.7(80)			
Mean ± SE		16.9±4.9	7.8±2.2	14.0±2.1	13.5±2.4	6.1±1.7	4.0	19.5

TABLE 2. Number of rodents caught within and outside an exclosure in big sagebrush near Burley, Idaho, 1957. *Significant difference ($P<.05$).

Species	Inside Replication 1	2	3	Total	Outside Replication 1	2	3	Total
Deer mouse	1	4	5	10	41	28	26	95*
Least chipmunk	0	0	0	0	4	3	4	11*
Harvest mouse	6	1	1	8	0	0	0	0*
Ord kangaroo rat	2	3	0	5	2	0	0	2
Great Basin pocket mouse	0	7	4	11	1	1	0	2*
Totals	9	15	10	34	48	32	30	110*

were caught inside the Piemeisel exclosure, 11 were trapped in the sagebrush-cheatgrass outside it (Table 2), further evidence that range depletion favors an increase in its density.

The yellow pine chipmunk (*Eutamias amoenus*), which occupies the higher parts of several ranges in the northern Great Basin (Raft River Mountains, Cache Peak-Mount Harrison, Jarbidge Mountains), is absent from the Silver City Mountains of Owyhee County, where it is replaced by *Eutamias minimus*. The occurrence of the least chipmunk in a subalpine fir (*Abies lasiocarpa*) community on Boulder Summit confirms its ability to successfully colonize a variety of habitats in the absence of a sciurid competitor.

Ord kangaroo rats (*Dipodomys ordi*) were most abundant in stands of kochia in the Raft River Valley (Table 4) and along roadsides where disturbed earth provided easy tunneling (Johnson 1961). It is more abundant on sandy than on gravel substrates (Fautin, 1946; Maxell and Brown, 1968). This species successfully colonizes wheatgrass seedings (Table 4). Road building has permitted its dispersal into broad stretches of shadscale formerly occupied exclusively by *Dipodomys microps*.

In the Raft River Valley, chisel-toothed kangaroo rats were 2-3 times more abundant in "healthy" shadscale than in depleted stands (Table 5). In the more pristine shadscale and winterfat communities near Mountain Home it was the most common, and sometimes the only, rodent trapped. Shadscale leaves comprise most of its diet (Johnson, 1961), and its distribution closely coincides with that of shadscale in the Intermountain West. Kenagy (1972) has found that the chisel-shaped lower incisors are used to strip away the hypersaline epidermis of shadscale leaves; hence, only the less saline mesophyll is ingested. This species was also common (6.7/100 trap days) in a hop sage (*Grayia spinosa*) community west of Malta.

Western harvest mice (*Reithrodontomys megalotis*) were most abundant in seeded stands of wheatgrass (Table 6) and in giant wild rye (*Elymus cinereus*) communities of the Raft River Valley. Further evidence of its affinity for denser grass habitats was manifest at the Piemeisel exclosure (Table 2) and in a Wyoming study (Maxell and Brown, 1968).

Great Basin pocket mice were most common in seeded stands of wheatgrass and in big sagebrush-Idaho fescue (*Festuca idahoensis*)-bluebunch wheatgrass (*Agropyron spicatum*) communities. Its numbers are reduced in sage-grass habitat types sustaining heavy grazing (Table 2). This species was common (to 7.4/100 trap days) in a black sage community south of Albion, Cassia County. Although often considered a semi-desert species, it was trapped on Boulder Summit, Owyhee County, in subalpine fir (2500 m) and in a subalpine meadow (2750 m) near Lake Cleveland, Cassia County.

Other rodents trapped in smaller numbers included the sagebrush vole (*Lagurus curtatus*), the little pocket mouse (*Perognathus longimembris*), and the desert woodrat (*Neotoma lepida*). The habitat affinities of these species and those previously discussed are summarized in Table 7. We also caught grasshopper mice (*Ony-*

TABLE 3. Mean catch of least chipmunks (N/100 trap days), Raft River Valley. Percent of total catch in parentheses.

Year	Month	Big Sagebrush	Shadscale Healthy	Shadscale Depleted	Crested Wheatgrass	Kochia	Greasewood	Halogeton
1955	Jul			6.3(41)			4.0(33)	
1956	Jul-Aug	0.3(2)	0	1.5(10)	0.5(2)		1.0(9)	1.3(5)
1957	Apr	0.9(3)	0.3(1)	1.8(8)	0.2(1)			0.2(1)
	Jun	3.6(13)	0.7(3)	8.7(28)	2.3(7)	4.3(21)		4.0(11)
	Aug	0	0.3(2)	2.7(14)	0.3(1)	3.0(24)		0
1958	Aug	0	2.0(9)	6.0(19)	0	0		
1959	Jun-Jul	0.3(9)	0	6.2(51)	0	1.0(20)	2.3(28)	
1960	Jun	0.3(2)	0	4.0(15)	0	0.7(10)		
	Aug			6.0(31)				
1964	May	2.7(5)		3.0(12)	0			
Mean ± SE		1.0±0.5	0.5±0.3	4.6±0.7	0.4±0.3	1.8±0.8	2.4	1.4

TABLE 4. Mean catch of Ord kangaroo rats (N/100 trap days), Raft River Valley. Percent of total catch in parentheses.

Year	Month	Big Sagebrush	Shadscale Healthy	Shadscale Depleted	Crested Wheatgrass	Kochia	Greasewood	Halogeton
1955	Jul			0			0	
1956	Jul-Aug	2.0(11)	0	0	0.3(2)		1.0(9)	2.0(8)
1957	Apr	0	0.3(1)	0	2.4(11)			3.3(11)
	Jun	4.9(17)	1.0(5)	0.3(1)	3.0(10)	3.3(16)		1.7(4)
	Aug	1.3(14)	1.0(7)	0	0.7(3)	2.7(21)		0
1958	Aug	0.7(3)	0	0.7(2)	0	4.0(30)		
1959	Jun-Jul	1.7(45)	0	0.2(2)	0.3(8)	1.7(33)	1.7(20)	
1960	Jun	1.0(6)	0	0.7(2)	1.0(11)	3.3(48)		
	Aug			0				
1964	May	4.0(7)		0.3(1)	1.3(6)			
Mean ± SE		2.0±0.6	0.3±0.2	0.2±0.1	1.1±0.4	3.0±0.4	0.9	1.8

TABLE 5. Mean catch of chisel-toothed kangaroo rats (N/100 trap days), Raft River Valley. Percent of total catch in parentheses.

Year	Month	Big Sagebrush	Shadscale Healthy	Shadscale Depleted	Crested Wheatgrass	Kochia	Greasewood	Halogeton
1955	Jul			4.7(30)			3.1(26)	
1956	Jul-Aug	2.0(11)	9.7(64)	3.2(22)	0		3.7(31)	0
1957	Apr	2.2(8)	4.0(16)	2.2(10)	0			0.2(1)
	Jun	2.2(8)	8.7(45)	1.0(3)	0	2.0(10)		0
	Aug	2.3(24)	5.3(39)	2.3(12)	0	0.7(5)		0
1958	Aug	4.0(18)	8.7(38)	3.3(11)	0	0		
1959	Jun-Jul	0.3(9)	1.3(33)	1.6(13)	0	0.7(13)	1.3(16)	
1960	Jun	0	2.7(14)	0.3(1)	0	0		
	Aug			0.3(2)				
1964	May	1.3(2)		4.0(16)	0			
Mean ± SE		1.8±0.4	5.8±1.2	2.3±0.5	0	0.7±0.4	2.7	0.05

TABLE 6. Mean catch of western harvest mice (N/100 trap days), Raft River Valley. Percent of total catch in parentheses.

Year	Month	Big Sagebrush	Shadscale Healthy	Shadscale Depleted	Crested Wheatgrass	Kochia	Greasewood	Halogeton
1955	Jul			0			0	
1956	Jul-Aug	0.3(2)	0	0.3(2)	8.7(40)		0	1.3(5)
1957	Apr	0.9(3)	1.0(3)	0	4.2(19)			3.6(12)
	Jun	0.4(2)	1.7(9)	0	0.7(2)	0.3(2)		5.3(16)
	Aug	0.3(3)	1.0(7)	0	3.0(13)	0		2.3(14)
1958	Aug	0	0	0	5.3(32)	0		
1959	Jun-Jul	0	0	0	0.7(17)	0	0	
1960	Jun	0	0	0	0	0		
	Aug			0				
1964	May	0		0	0			
Mean ± SE		0.2±0.1	0.5±0.3	0.03	2.8±1.1	0.06	0	3.1

TABLE 7. Relative abundance of rodents in southern Idaho habitat types. ‡ = abundant (often > 10/100 trap days); § = common (often > 5/100 trap days); * = present, caught in small numbers; † = rare or absent. Scientific names abbreviated.

Habitat Type	P.m.	E.m.	D.o.	D.m.	R.m.	P.p.	L.c.	P.l.	N.l.
Greasewood	§	*	*	*	*	†	†	†	*
Salt sage	§	*	*	*	†	*	†	†	†
Healthy shadscale	§	*	*	§	*	*	†	*	*
Depleted shadscale	‡	§	*	*	*	†	†	*	†
Hopsage	§	*	*	§	*	†	†	†	*
Winterfat	*	*	†	§	†	*	†	†	†
Kochia	§	*	*	*	*	*	†	†	†
Halogeton	§	*	*	*	*	*	†	†	†
Sagebrush-cheatgrass	‡	*	*	*	*	*	*	*	*
Sagebrush-perennial grass	§	*	†	†	*	§	*	†	†
Crested wheatgrass	§	*	*	†	§	§	*	*	†
Black sage	§	*	†	*	*	*	†	†	*
Mountain mahogany	§	*	†	†	†	*	†	†	†
Juniper-big sage	§	*	†	†	†	*	†	†	*

chomys leucogaster) in almost all habitat types sampled, but its catch is not reported here because of the likelihood that it shuns rolled oats as bait. Small numbers of montane (*Microtus montanus*) and long-tailed voles (*M. longicaudus*) were also taken in grassy habitats throughout southern Idaho. Townsend ground squirrels (*Citellus townsendi*) were trapped in shadscale and winterfat communities. A few antelope ground squirrels (*Citellus leucurus*) were taken near the Bruneau Sand Dunes, Owyhee County.

Halogeton, an introduced annual chenopod, has invaded large areas of depleted shadscale in southern Idaho (Tisdale and Zappettini, 1953). Dense stands of halogeton sometimes support large numbers of deer mice (to 26/100 trap days) and a few of the other common species.

Former sage-grass habitat types which support weedy annuals contain few rodents. Heavy grazing and repeated fires have fostered the establishment of nearly pure stands of cheatgrass over vast areas of southern Idaho (Stewart and Hull, 1949). Such sites support only a few deer mice and Great Basin pocket mice. Medusahead (*Elymus caput-medusae*), a more recent invader, has replaced cheatgrass over nearly three-quarter of a million acres in southern Idaho (Hironaka, 1961). Nearly pure stands of this annual support even fewer rodents: only 8 deer mice were trapped in 900 trap days east of Weiser, Washington County. Former sagebrush-grass sites near Mountain Home supporting Russian thistle (*Salsola kali*) contained few rodents, but we caught considerable numbers (12.7/100 trap days) of western harvest mice in a stand of Russian thistle near Bridge, Cassia County. Former sagebrush-grass sites

supporting stands of tansy mustard (*Descurainia pinnata*) or peppergrass (*Lepidium perfoliatum*) contain few rodents.

Much of this sagebrush range can be rehabilitated through reseeding with drought-resistant wheatgrasses. Although certain grass-adapted species are more numerous in wheatgrass seedings, the total rodent catch remains about the same as that on depleted sagebrush sites.

Discussion

The effects of grazing on rodent abundance has received considerable attention over the past half-century (reviews by Bond, 1945; Howard, 1953). Most of these studies have been conducted in central California, the Southwest, or on the Great Plains. Our data corroborate earlier findings that range depletion favors an increase in deer mice populations (Phillips, 1936; Quast, 1948) and tends to diminish the numbers of western harvest mice (Quast, 1948). We found that Great Basin pocket mice, like two other kinds of pocket mice in Arizona (Reynolds and Haskell, 1949), were most abundant in vigorous stands of perennial grasses. Like them, its numbers were reduced on depleted ranges.

There are interspecific differences in the responses of kangaroo rat populations to range depletion. While several species are more abundant on grazed sites (McCulloch, 1962; Reynolds, 1958; Quast, 1948), the numbers of chisel-toothed kangaroo rats are reduced in depleted shadscale stands (Table 5). Thus it is sometimes hazardous to generalize, predicting the response of a rodent population to habitat alteration, basing the prediction on the response expected from a related species.

In an earlier investigation, Fautin (1946:279) found that deer mice occurred in relatively low numbers in six communities within the shadscale and sagebrush associations of west central Utah. We found deer mice the most abundant rodent in all communities in the Raft River Valley, probably a result of its long history of heavy use by livestock. Although we found least chipmunks in all the habitat types trapped in the valley, Fautin found them restricted to sagebrush sites in Utah. Again, we ascribe this difference to the range depletion at our trapping sites.

The highest rodent numbers encountered in this study (46.7/100 trap days) were those of deer mice in a big sagebrush community in the Raft River Valley in May 1964 (Table 1). This level is greatly exceeded by microtine populations during irruptions (Piper, 1909; Federal Cooperative Extension Service, n.d.). As hunters, insectivorous and granivorous species such as the deer mouse search greater distances for food (McNab, 1963), and it is unlikely that they cannot achieve the high densities found in some foliage herbivore populations.

Rodent populations often exhibit abrupt changes in density (Horn and Fitch, 1942; Reynolds, 1958). We found that deer mice populations regularly changed by factors of 2 or 3 and sometimes

by a factor of 10 from one year to the next (Table 1). The catch of deer mice was 18/100 trap days in big sagebrush near Malta in 1958. It fell to 1.3/100 trap days in 1959 and then increased to 15.3/100 trap days the following year. Similar changes occurred in populations at other trapping sites during the same time interval (Table 1). These concurrent changes in populations of different species are in contrast to the independent changes occurring in rodent populations on desert grasslands in New Mexico (Wood, 1965, 1969).

In the Raft River Valley where trapping was conducted on a bimonthly basis during the 1957 field season, peak densities occurred in June for most species. The proportion of juvenile mice in the catch declined steadily, indicating that breeding terminated in late spring. Rodent populations reached low levels at these sites the following year.

Our understanding of the dynamics of small mammal populations will reach maturity only after we are able to identify those variables which most affect density. We can then develop sensitive models to predict population change, one of the goals of the International Biological Program, Biome Studies.

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